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NSG-5009

SEMI-ANNUAL REPORT

to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

for

Characterization of the Physico-Chemical Properties

of Polymeric Materials for Aerospace Flight

Office of Federal Programs
Bowie State College
Bowie, Md. 20715

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Dr. Michael Rock

July 21 1978

Date

(NASA-CR-156935) CHARACTERIZATION OF THE PHYSICO-CHEMICAL PROPERTIES OF POLYMERIC MATERIALS FOR AEROSPACE FLIGHT Semiannual Report (Bowie State Coll., Md.) 9 p HC A02/MF A01 CSCL 07C G3/27

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INTRODUCTION

The major source of contamination in spacecraft is internal. Outgassing of polymers, greases, and other organic materials at low pressures in space and test causes contamination. Condensation of contaminants on cold surfaces, such as particle detectors or optical surfaces will seriously reduce the efficiency of such units and give erroneous results. In addition, excessive outgassing may lead to corona inception and multipacting and can modify physical properties of the polymers.

Materials intended for use in spacecraft are routinely tested at low pressures, and outgassed substances are condensed on cold surfaces at liquid nitrogen temperature, -196°C. These condensates are then analyzed by infra-red spectroscopy, and gas chromotography-mass spectroscopy.

At GSFC, the polymers are tested and allowed to outgas isothermally at 125°C and 10^{-6} torr or less. Valuable information can be obtained by extending the temperature range below and above 125°C. The performance of substances of interest to NASA were investigated by thermogravimetric analysis (TGA) from room temperature to 450°C or until the substance decomposed.

Thermogravimetric analysis of a substance is a useful technique for studying its thermal nature in both static and dynamic thermal environments. It gives considerable insight into the stability and characterization of substances and the changes they undergo in varying thermal environments. The system is able to get pressures down to 1 micron or 10^{-3} torr.

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PROCEDURE

Thermogravimetric analyses are run on a DuPont 950 Thermogravimetric Analyzer. All runs were performed at standard pressure of about 1 microns (10^{-3} torr).

The standard program proceeds as follows:

Each sample is run isothermally at ambient temperature (20°C to 30°C) for one-half hour or ten minutes after reaching minimum pressure.

The temperature is then programmed to rise at maximum rate (approximately 50°C/min.) to the isotherm temperature. The recorder is set to measure temperature vs. weight during this phase. We thus measure temperature overshoot as the sample is heated.

The sample is then held isothermally at the desired temperature for 24 hours and the weight is measured as a function of time. The final step, the temperature decomposition phase, is programmed to rise at 3°C to 4°C per minute from the established isothermal temperature to 450°C or until the sample decomposes.

The four thermal steps are:

1. Room temperature isotherm.
2. Room temperature to isotherm temperature, with the unit previously set to stop at the desired isotherm temperature.
3. Isothermally at desired temperature for 24 hours.
4. Sample is heated from isotherm to decomposition.

DISCUSSION OF TABLES

The following is an explanation of columns 3, 4, 5, 6, 7, and 8 in the tables.

Column 3 — Shows the weight loss of the sample at ambient temperature (20°C - 30°C).

Columns 4 and 5 — As the sample is heated to the isotherm temperature, the rate of weight loss increases. This rapid rate of weight loss persists for a short time after the isotherm temperature has been reached. The rate of weight loss then decreases and levels off. There appears to be a loss of volatiles during the heating phase with some of the volatiles coming off after the isotherm has been reached. These two portions, that which comes off before the isotherm is reached, and that which comes off at the isotherm, are listed seperately in columns 4 and 5. The sum of columns 4 and 5 gives the total weight of these volatiles lost.

Column 6 — After the weight curve levels off, there is a continuing slow loss of weight at the isotherm. This weight loss is measured for one day, and the values are listed in column 6.

Columns 7 and 8 — After one day, the temperature is programmed to rise at 3°C to 4°C per minute. The recorder graphs temperature vs. weight. The graph starts as a straight line; at some temperature the graph curves down, meaning that the rate of weight loss is increasing. The straight line portion of the graph is extrapolated. Column 7 lists the temperature at which the line curves down; the temperature at which the rate of loss is noticeably greater than

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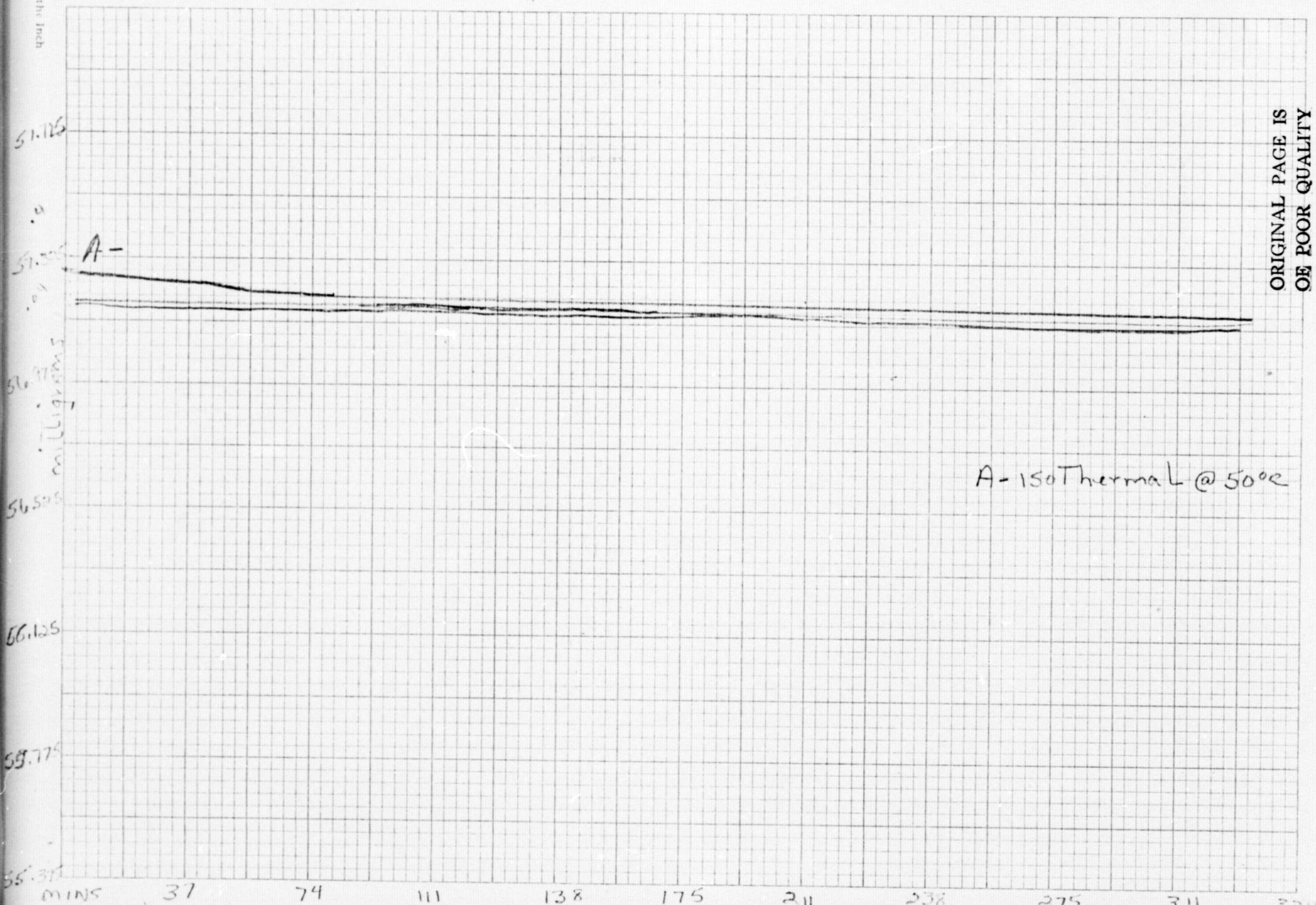
Columns 7 and 8 (continued)

the constant rate. Column 8 lists the temperature at which the actual curve is 0.2 mg (or 0.2 inches) below the extrapolated line. This measurement is an arbitrary one and was chosen because it is less subjective than the figure in column 7 and gives another point of comparison between different samples.

Run # 113

Sample: 1170 3M Tape



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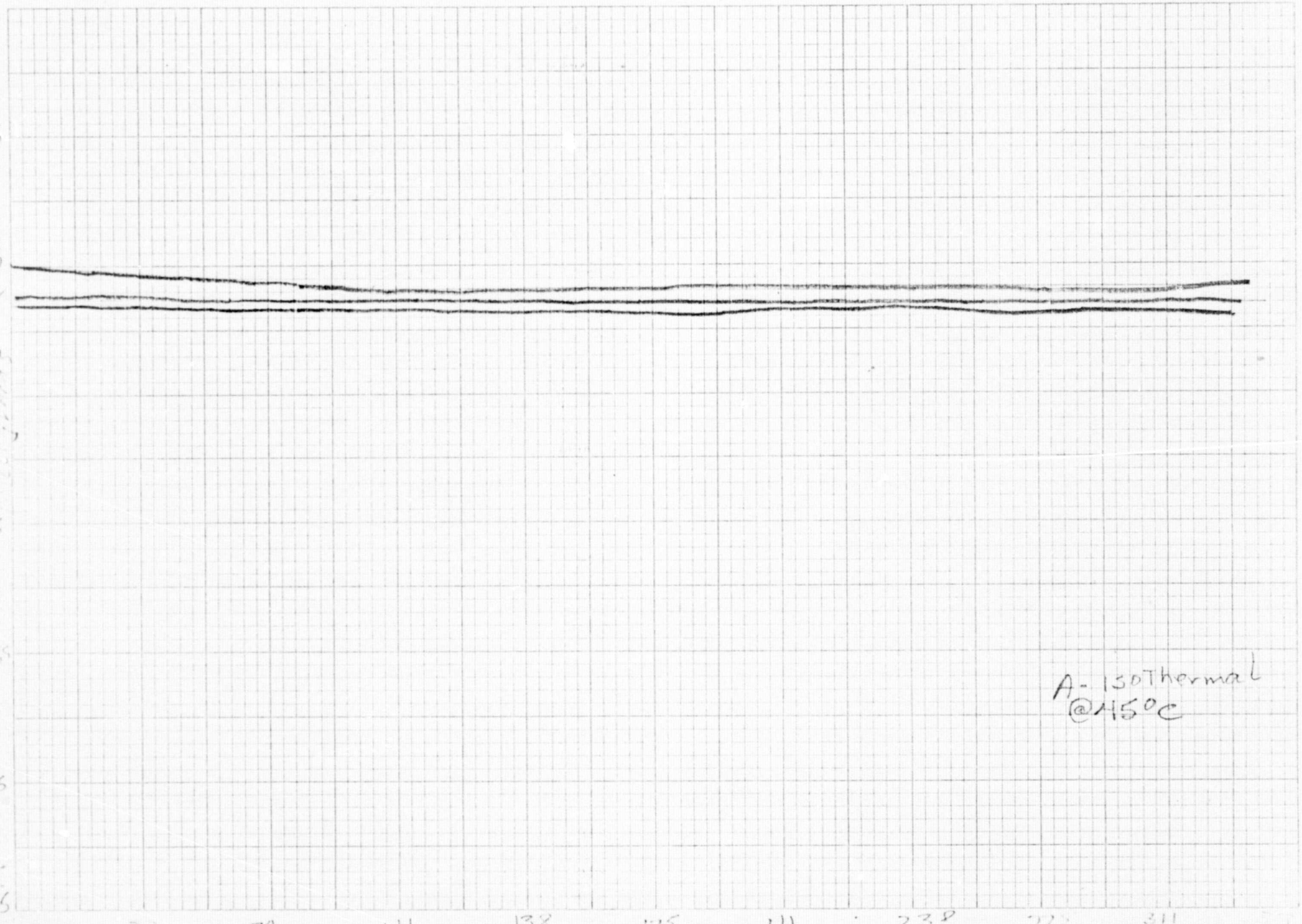
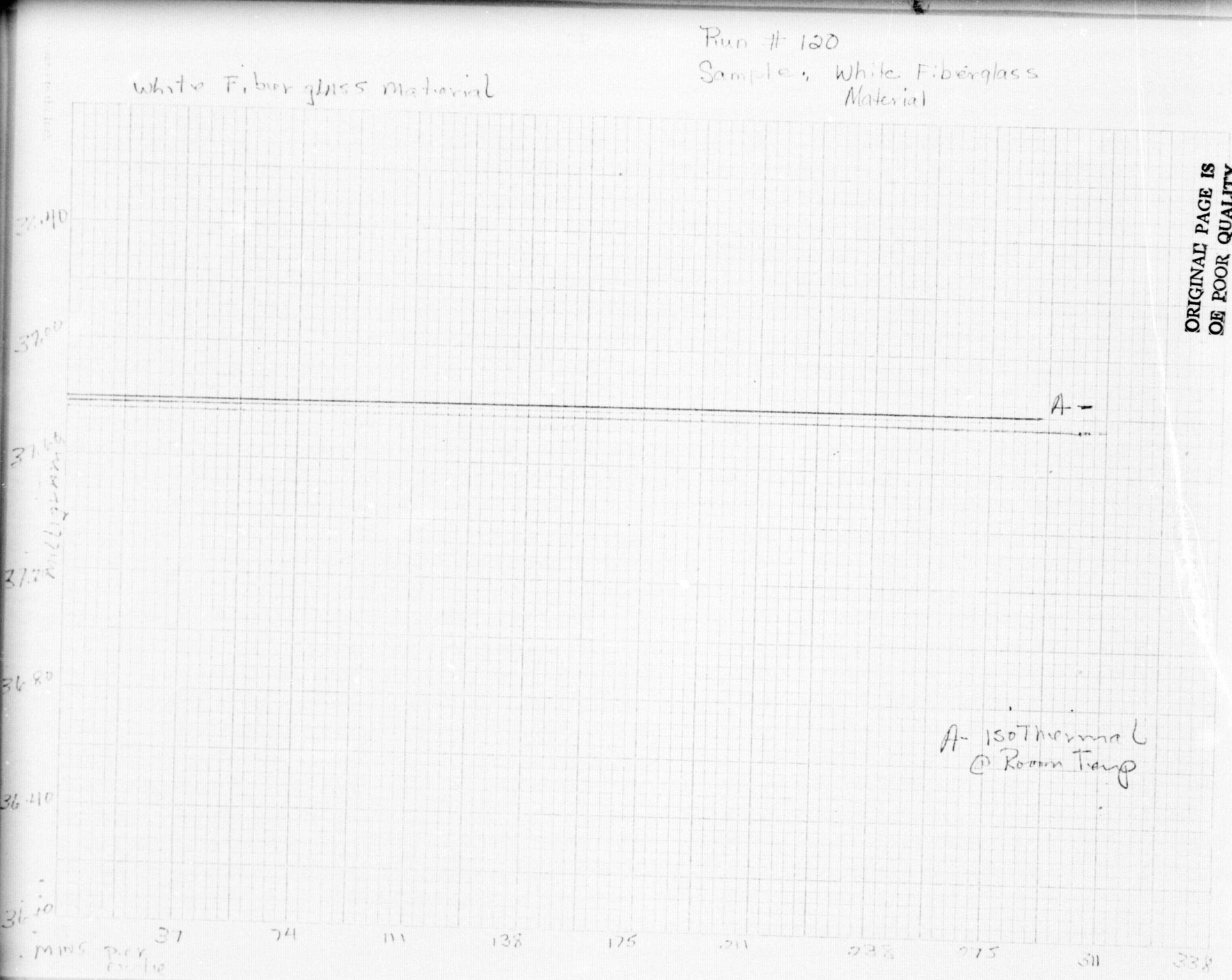
Run # 114

Sample: 1170 3M Tape



Run # 120
Sample: White Fiberglass Material

White Fiber glass Material



A- Isothermal @ Room Temp

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SAMPLE & # OF RUN	WEIGHT	LOSS °C ROOM TEMP.	LOSS R.T. TO 125°C	LOSS TO LEVEL OFF	LOSS @ 125°C	TEMP. DECAY	TEMP. 0.2 mg DEPARTURE
1170 3M Tape 113	57.325 mg	.12 mg	-	0.12 mg	-	-	-
1170 3M Tape 114	50.15 mg	.8 mg	-	.6 mg	-	-	-
White Fiber-glass material #120	37.80 mg	.04 mg	-	.04 mg	-	-	-

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